



*Heavy Reading* – Independent quantitative research and competitive analysis of next-generation hardware and software solutions for service providers and vendors

November 2007

## **White Paper: Delivering Business Class Ethernet - A Perspective On Level 3's Comprehensive Ethernet Services Portfolio**

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**Enterprises are adopting** high-performance Ethernet services to easily and cost-effectively scale their communications networks and converge services and applications onto a common network.

**Enterprises have embraced** all of the key flavors of Ethernet connectivity services, but they are particularly interested in multipoint-to-multipoint (E-LAN) services that support a rich array of value-added services and applications over a single interface at each site.

**Level 3** offers one of the broadest Ethernet service portfolios in North America. This includes all principal connectivity configuration options, extensive reach within and between metro areas, bandwidth scalability, and service level agreements across all offerings.

**Level 3's Ethernet solutions** can be tailored to meet customer requirements in a variety of industry verticals, including finance, health, research & education, and media.

The Ethernet services market has emerged as one of the fastest growing sectors in the telecom industry due to the fact that new network technologies have enabled operators to deliver services that are more scaleable, flexible, and cost effective than traditional data services offerings. Enterprises are enthusiastically embracing these emerging high-performance Ethernet services to control communications costs, improve productivity, and build resilient communications and IT infrastructures for today's on-demand business environment.

Enterprises have expressed growing interest in all major Ethernet services, including Ethernet Private Lines, Ethernet Virtual Private Lines, and Ethernet Virtual Private LANs. They appear especially attracted to multipoint services that enable them to extend Ethernet LANs across metro-area and wide-area networks and support many services over a single interface (UNI) at each location. New E-LANs built with MPLS/VPLS technology are designed to support a wide range of Ethernet access-based applications like VOIP, storage extension, and Internet access.

While enterprises currently face limited choices when it comes to inter-metro E-LANs based on next-generation technologies, a growing number of North American operators are rolling out or planning to deploy such services over the next 12 to 18 months. And other service providers – including Level 3 Communications, which is profiled in this report – are taking steps to include more value-added features with their current E-LAN solutions.

Recognizing the potential for Ethernet to reshape the data services landscape, Level 3 Communications has assembled some of the most competitive point-to-point, point-to-multipoint, and multipoint-to-multipoint offerings in the industry. It has one of the broadest geographic reaches of any North American operator, supports a wide variety of Ethernet services that scale from 1 Mbps to 10 Gbps, and offers service level agreements (SLAs) across its entire portfolio.

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## I. Introduction

Market feedback from enterprise users and telecommunications service providers indicates that the Ethernet services market is one of the fastest-growing sectors in the communications industry – outpacing next-generation IP/MPLS VPNs and leaving legacy Frame Relay, ATM, and TDM private line services in the dust. Enterprises increasingly are shifting away from legacy services toward Ethernet and IP/MPLS VPNs because the newer services take advantage of next-generation network technologies to deliver greater performance and value at competitive prices. Enterprises are particularly interested in the high speed connectivity, flexibility, and cost-effectiveness of Ethernet and its role in supporting convergence of real-time and non-real time applications on a common network architecture.

Service providers in North America and worldwide are expanding their Ethernet service offerings to meet burgeoning enterprise interest in Ethernet. They are rolling out sophisticated yet cost-efficient, point-to-point, point-to-multipoint, and multipoint-to-multipoint Ethernet services with enhanced performance, reliability, scalability, and flexibility. And they are deploying new Ethernet access platforms to more rapidly deliver services to on-network and off-network locations within and between cities.

As service provider competition on the Ethernet front intensifies, operators are raising the bar by offering service performance guarantees, greater bandwidth scalability from 1 Mbps to 10 Gbps, user-friendly Web-based service portals, and more value-added services and applications.

This white paper provides an overview of Ethernet services market trends and spotlights Level 3 Communications, an operator that has a feature-rich Ethernet portfolio and one of the broadest geographic coverage areas in the U.S. market. We examine major supply and demand drivers fueling growth in the Ethernet services market, describe the wide range of emerging Ethernet service options, and explore why multipoint services are particularly attractive to enterprises. We then provide an in-depth profile on Level 3 Communications—exploring this service provider's Ethernet services strategy, portfolio, coverage, and web-based services portal. While Level 3's Ethernet portfolio targets a broad range of industry verticals and is available on a wholesale basis for other operators, we will focus on how its services help address the requirements of some of the key verticals where Ethernet has become increasingly popular: finance, healthcare, research & education, and media, finance, and research and education.

## II. Ethernet Services Market Drivers & Trends

Developments across multiple fronts are generating momentum for Ethernet services that are transforming the data services markets in North America and much of Europe and Asia.

### 2.1 Emergence Of Business Class Ethernet

Gone are the days of "best-effort-only" Ethernet services that promised buckets of cheap bandwidth but not a whole lot else. The Ethernet services hitting the market today tend to offer more robust features that make them more attractive to a larger number of enterprise customers. These carrier-class features include rapid, SONET-like restoration; end-to-end SLAs that guarantee high security and availability, low latency (frame delay), low jitter (frame delay variation), and low packet loss; seamless support for voice applications; robust service management; and greater scalability than traditional Ethernet solutions.

The shift to Ethernet services with more carrier-class features is being driven by multiple factors.

- 1) Equipment vendors have introduced dozens of carrier Ethernet switch/router, transport, and access platforms in the past three years that enable cost-effective network and ser-

vice convergence. Software vendors also have developed new solutions that provide enhanced service management and service assurance capabilities.

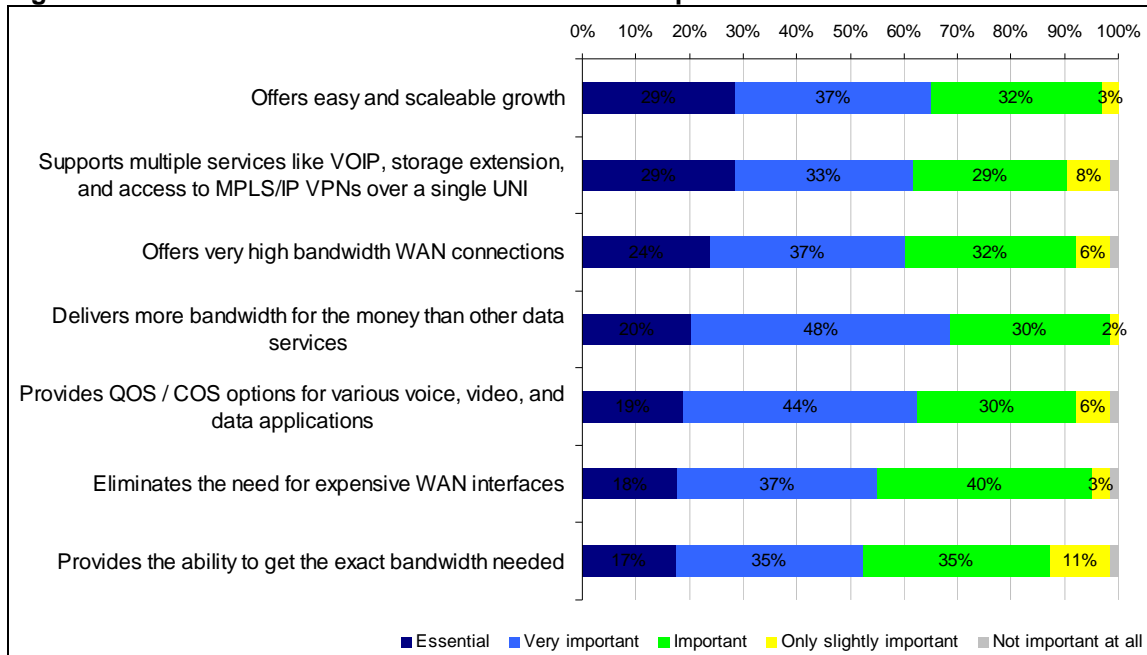
- 2) Standards bodies—including the Metro Ethernet Forum (MEF), IEEE, ITU-T, and IETF—have invested enormous energy to develop dozens of Ethernet-related standards in the past several years. The 130+ member MEF has been particularly active and become increasingly important. It is the leading voice promoting Ethernet's adoption, shaping service definitions, and driving industry cooperation on standards and related high-performance service and management features.
- 3) Service providers have embraced Ethernet to deliver a richer set of services and scaleable bandwidth over a more efficient infrastructure. They have invested billions of dollars in deploying carrier Ethernet-related transport and aggregation platforms, and many are adding on-network and off-network Ethernet access points at a fairly rapid clip.
- 4) Enterprises want to better control their telecom expenditures and roll out new applications to improve productivity by leveraging more cost-effective communications technologies. Enterprises also want to make their communications infrastructures more flexible and resilient in the face of challenges and opportunities created by intensifying competition, uncertain customer demand, regulatory developments, and accelerated business cycles.

The following discussion explores some of the key enterprise service demand drivers and trends.

## **2.2 Enterprises Embrace Ethernet For Easy Growth & Service Convergence...**

Market feedback and survey data from *Heavy Reading* indicate that enterprises are embracing Ethernet first and foremost for the ease with which it allows them to cost-effectively scale with growing bandwidth requirements (**Figure 2.1**). Ethernet enables enterprises to reduce communications costs and increase business productivity because it offers significant performance-price advantages versus other network technologies like SONET and ATM. Only DWDM, used to build high-capacity optical networks, has delivered more performance/price improvements than Ethernet over the past decade. Operators like Level 3 that have strategically integrated these two powerful technologies in their networks have managed to consistently deliver much greater bandwidth at the same or less cost, compared to other solutions.

**Figure 2.1: What Makes Ethernet Attractive For Enterprise Users?**



Source: Heavy Reading, 2007 User Survey On Ethernet Services.

As Ethernet has become more feature-rich, enterprises have been attracted by its ability to support multiple services like VOIP, storage extension, and access to MPLS/IP VPNs over a single user network interface (UNI). Enterprises and operators alike are increasingly viewing Ethernet as a universal service jack for all types of communication services—or what Level 3 refers to as a Universal Service Platform.

**As a market driven technology, Ethernet delivers a virtuous cycle of innovation:**

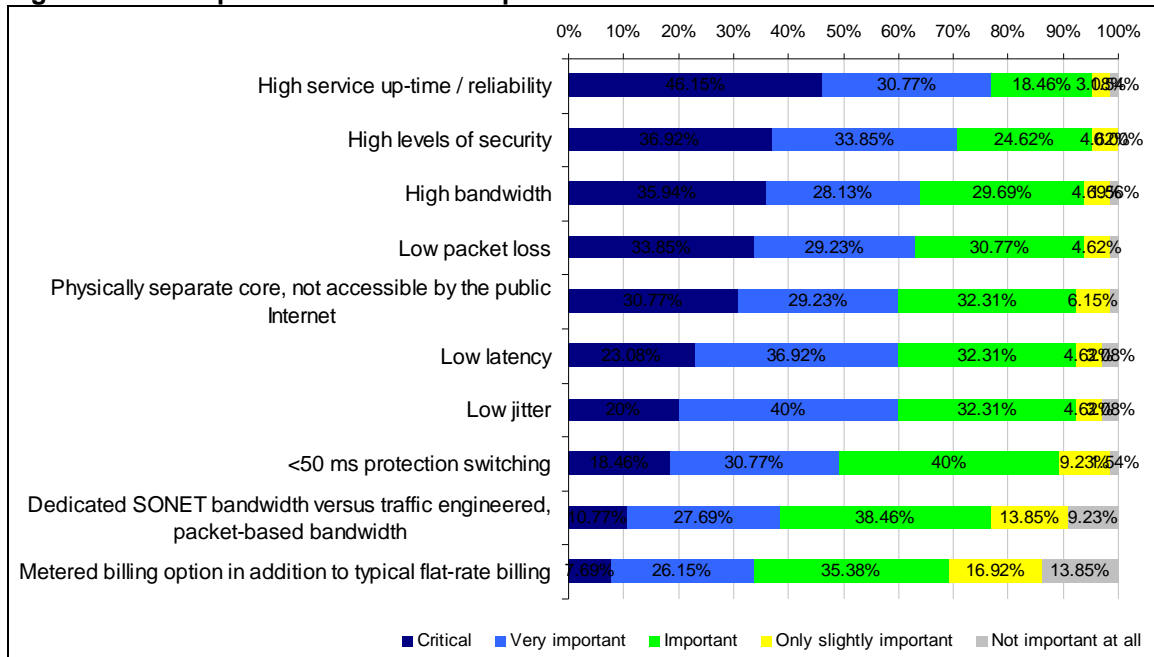
- The superior economics of Ethernet drive large volumes.
- Large volumes drive investment in new generations of technology.
- New generations improve scalability and deliver even better economics.

Service providers are stepping up to meet enterprise demand for Ethernet as a convergence platform of choice by (1) enabling Ethernet access to many legacy and next-generation services and applications, (2) rolling out more virtual connectivity services that permit service multiplexing at the UNI, and (3) starting to provide quality of service guarantees and class of service options for various voice, video, and data services and applications delivered over Ethernet connections.

### 2.3 ...But Many Want A Richer Set Of Features To Meet On-Demand Needs

While enterprises are enthusiastic about using Ethernet, many are placing high demands on operators to deliver more robust services. Heavy Reading's 2007 User Survey On Ethernet Services revealed that more than 70% of IT managers view service uptime/reliability and security as critical or very important in any offering (Figure 2.2). At least 60% of respondents also indicated that their companies place a premium on high bandwidth, low packet loss, low latency, low jitter, and a physically separate core that is not accessible by the public Internet.

**Figure 2.2: Enterprise Views On The Importance Of Ethernet Service Features**

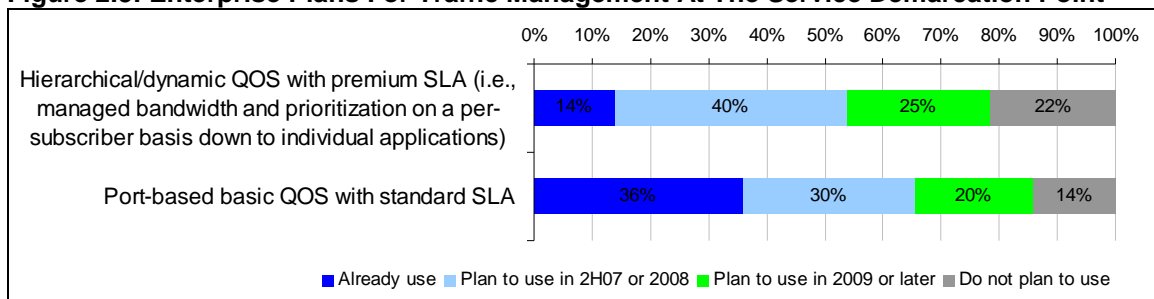


Source: Heavy Reading, 2007 User Survey On Ethernet Services.

Enterprises are in the midst of realigning their business structures and processes to better anticipate challenges and opportunities before they happen and to build flexibility into communications and IT infrastructures to handle events as smoothly as possible. Carrier Ethernet services can help address a number of enterprise priorities in this regard, including efforts to: (1) lower bandwidth, administration, and maintenance costs by consolidating best-effort and mission-critical services over a single, converged network infrastructure; (2) ensure secure, reliable, and prioritized delivery of data from a wide range of applications; (3) purchase bandwidth more in line with actual capacity requirements; (3) respond quickly to shifting market opportunities, enhance collaboration, and speed up analytics through the use of grid computing and on-demand computing.

While relatively few enterprises enjoy advanced traffic management today, many told *Heavy Reading* that they are looking forward to using more dynamic traffic management that will increase their ability to adapt to changing communications requirements. More than half of IT managers who responded to survey questions about traffic management said that they intend to use hierarchical/dynamic QOS by the end of 2008 (**Figure 2.3**). This capability permits managed bandwidth and prioritization on a per-subscriber basis down to individual applications.

**Figure 2.3: Enterprise Plans For Traffic Management At The Service Demarcation Point**

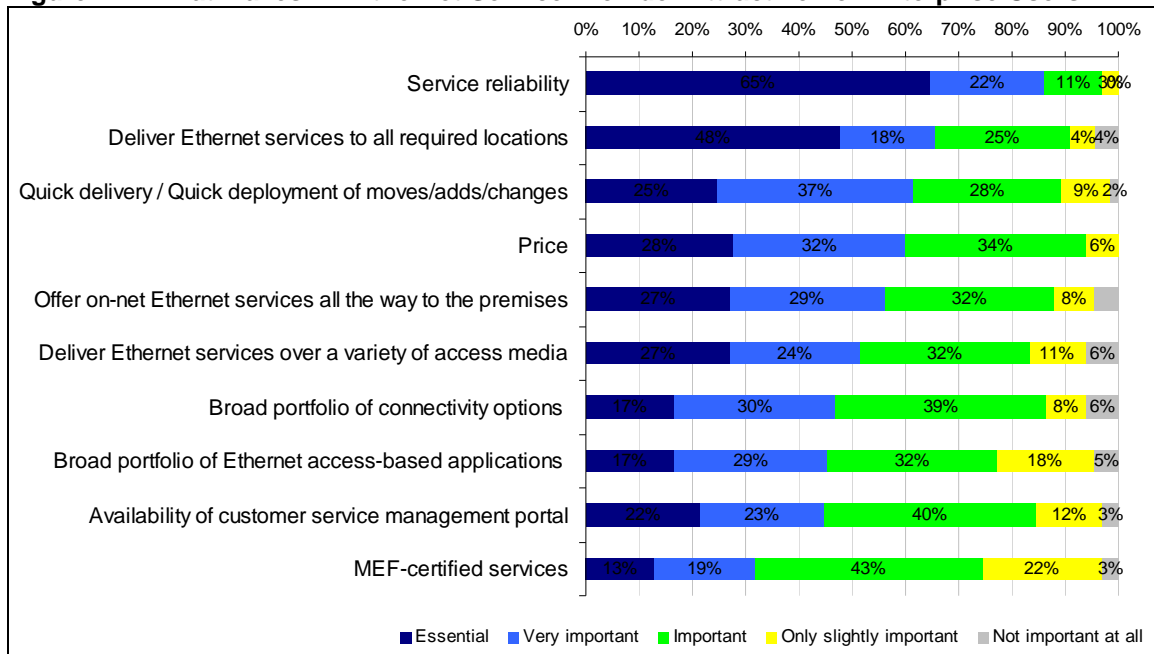


Source: Heavy Reading, 2007 User Survey On Ethernet Services.

### 2.3 Enterprises Seek Reliability & Service Ubiquity When Choosing A Provider

Heavy Reading survey feedback from enterprises indicates that service reliability is by far the most important factor when it comes to selecting a particular provider (**Figure 2.4**). Eighty-seven percent of IT managers said that reliability is either essential or very important in their decision-making process. The next most important factor is the ability of an operator to deliver Ethernet to all required locations. In the past, this has been the biggest hurdle slowing Ethernet adoption, but new access solutions that do not require fiber are helping operators address this concern.

**Figure 2.4: What Makes An Ethernet Service Provider Attractive For Enterprise Users?**



Source: Heavy Reading, 2007 User Survey On Ethernet Services.

### 2.4 Enterprises Enjoy Many Ethernet Connectivity & Access Options

Heavy Reading's Ethernet Services Framework (**Figure 2.5**) illustrates the dozens of Ethernet connectivity and access-based service options emerging in the market for enterprises and service providers. 2007 survey feedback from Ethernet service providers indicates the vast majority of operators worldwide intend to support a multitude of Ethernet connectivity services and Ethernet-based applications within the next couple of years, but it is fairly uncommon to find a carrier that can offer all or most of these today.

- **Ethernet connectivity services:** These are Layer 1- and 2-based services in which native Ethernet or Ethernet over another medium provides connections among two or more user network interfaces (UNIs).
- **Ethernet access-based enterprise services:** These are services and applications that can be delivered over Ethernet connections to provide added value for customers. What we are talking about here is extending the concept of Ethernet as the “universal jack” from the enterprise LAN environment to the MAN and WAN environments. The Ethernet interface becomes a conduit for supporting many different types of applications.

**Figure 2.5: Ethernet Services Framework**

|  |                     |                          |                     |                         |
|--|---------------------|--------------------------|---------------------|-------------------------|
| Business Applications & Network Services | VOIP                | Disaster Recovery        | Distance Learning   | Video Streaming         |
|  | Video Transport     | Storage Extension        | E Access To IP VPN  | Content Distribution    |
|  | VOIP Transport      | Internet Access          | E Access To FR/ATM  | Private Line - CE       |
| Wholesale                                | Cell Site Backhaul  | WiFi/WiMAX Backhaul      | DSLAM Backhaul      | UMTS Backhaul           |
| Ethernet Connectivity                    | Eth Private Line    | Eth Virtual Private Line | Eth Private LAN     | Eth Virtual Private LAN |
|  | Inter-Metro – Int'l | Inter-Metro – Int'l      | Inter-Metro – Int'l | Inter-Metro – Int'l     |
|  | Inter-Metro – Nat'l | Inter-Metro – Nat'l      | Inter-Metro – Nat'l | Inter-Metro – Nat'l     |
|  | Intra-Metro         | Intra-Metro              | Intra-Metro         | Intra-Metro             |

Sources: Heavy Reading.

**Figure 2.6: Ethernet Connectivity Service Definition Highlights**

|  | Umbrella Ethernet Service Type          |  |
|--|---|--|
| EVC to UNI Relationship  | E-Line<br>(Point-to-Point)              | E-LAN<br>(Multipoint-to-Multipoint)      |
| Port-Based Service<br>Dedicated Bandwidth                        | Ethernet Private Line<br>(EPL)          | Ethernet Private LAN<br>(EPLAN)          |
| VLAN-Based Service<br>(Service Multiplexing)<br>Shared Bandwidth | Ethernet Virtual Private Line<br>(EVPL) | Ethernet Virtual Private LAN<br>(EVPLAN) |

Sources: Metro Ethernet Forum (MEF), Cisco, and Heavy Reading.

## 2.5 Enterprises Are Embracing Both Major Ethernet Service Types

Over the past couple of years, enterprises generally have stepped up purchases of both major types of Ethernet enterprise services as defined by the MEF—point-to-point and point-to-multipoint E-Line services and multipoint-to-multipoint ELAN services. The most popular versions of these services offered by operators and adopted by enterprises thus far have been Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services delivered within metro markets.

Market feedback from enterprise surveys and interviews with operators suggests that we should see particularly strong growth in the adoption of E-LAN services in the next few years, as their performance, reliability, scalability, and flexibility continues to improve. Early feedback from *Heavy Reading's* 2007 User Survey On Ethernet Services suggests a 40%+ surge in the number of enterprises using E-LAN services is possible over the next 18 months or so.

E-LAN services come in two general flavors: (1) Ethernet Private LAN (EPLAN), which is a port-based service that uses dedicated bandwidth and (2) Ethernet Virtual Private LAN (EVPLAN), which is a VLAN-based service that uses shared network resources

**Combine the concept of Ethernet as the “universal service jack” to the WAN with the ability to provide multipoint Ethernet connectivity, and you have the makings of a very flexible and attractive service.**

(**Figure 2.6**). The EVPLAN service is the Ethernet service generating the greatest buzz in the market, largely because it is the most differentiated from traditional data services and offers a lot of flexibility for supporting diverse enterprise requirements.

From the enterprise perspective, an EVPLAN looks as if all sites are connected to the same Ethernet LAN and the entire network appears like a Layer 2 switch, with multiple services supported over a single interface (UNI) at each customer location. In contrast to today's dominant Layer 2 service – Frame Relay – an EVPLAN is easier to provision and manage and is potentially more economical because subscribers can use the same Ethernet technology in the LAN, MAN, and WAN and they only need one local access connection per site, no matter how many locations are linked. An EVPLAN also provides enterprises an appealing alternative to a Layer-3 IP VPN from the standpoint that the customer can easily configure its routers on top of the Layer 2 architecture and is not required to handover these platforms to be managed by a service provider. In addition, EVPLAN services support multiple protocols, instead of just the IP protocol. With an EVPLAN, all Layer 3 protocols used across the LAN can also now be used between offices across the WAN with no translation hassles.

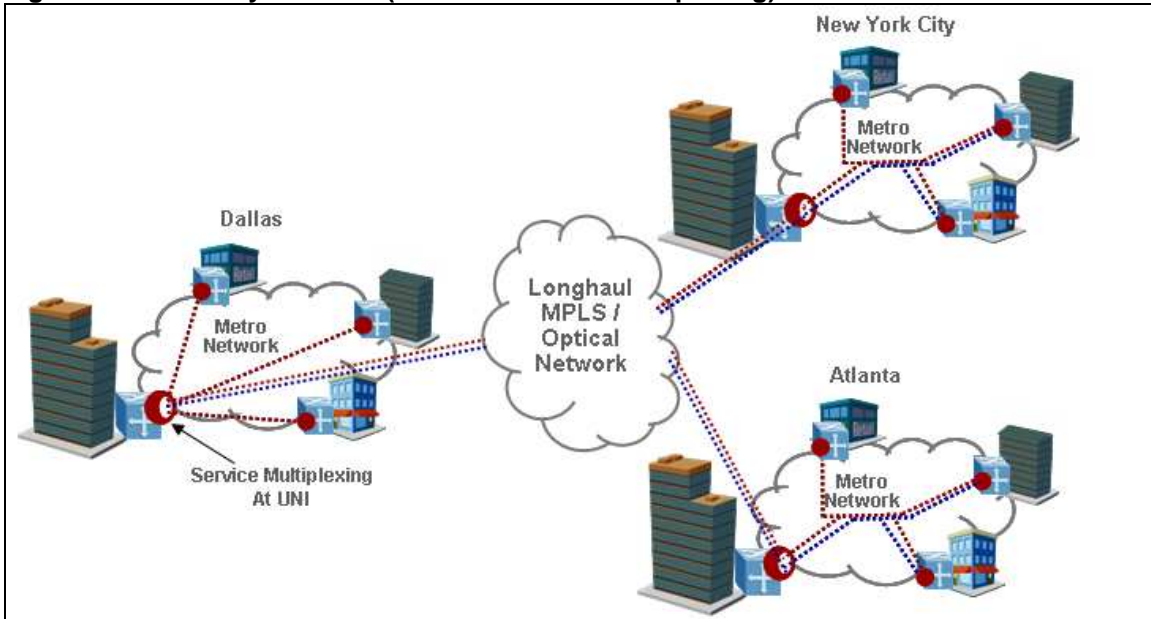
## **2.6 Inter-City EVPLANS Take Multipoint Services To A New Level**

The connectivity requirements of a good percentage of businesses can be satisfied by simply using EVPLANS to link several sites within a metro area, but many enterprises ultimately want to obtain multipoint service connectivity from any location not just within a metro area, but within a region, across the country, or across the globe. Following the same path that Frame Relay services took, these enterprises undoubtedly will expect inter-metro EVPLANS to come with a high degree of reliability and a rich set of features similar to those found on intra-metro EVPLANS.

Relatively new inter-metro EVPLANS based on a shared MPLS/VPLS network core are well-suited to essentially enable real-time access over long distances to mission-critical applications, such as enterprise resource planning (ERP), customer relationship management (CRM), supply chain management (SCM), storage area networking (SAN), VOIP, and Web-based analytics (**Figure 2.7**). Emerging carrier-grade capabilities can help overcome real-time services bottlenecks and other challenges by assigning non-critical traffic a lower priority, ensuring quality performance for voice and multi-media applications, and providing solid SLAs that guarantee low latency, high availability, and high packet throughput for other mission-critical applications between, as well as within, metro areas.

Enterprises face a fairly limited choice when it comes to inter-metro EVPLANS in the United States, but the list is growing, and the feature sets on existing service are improving with the advance of technology. Operators currently offering national inter-city EVPLANS based on VPLS technology include Level 3 Communications, Yipes Enterprise Services, Time Warner Telecom, MASERGY, and Verizon Business (which launched its service in March 2007).

**Figure 2.7: Inter-City EVPLAN (Includes Service Multiplexing)**

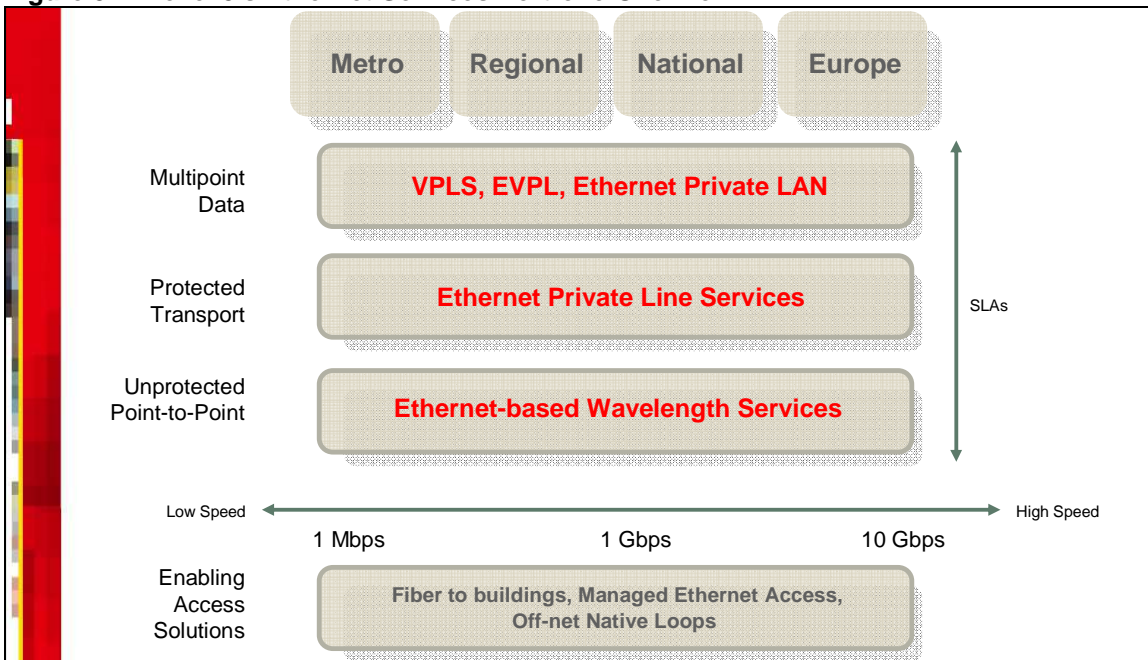


Sources: MEF and Heavy Reading.

### III. Level 3 Communications Ethernet Profile

Heavy Reading research indicates Level 3 has put together one of the most competitive portfolios of intra-metro and inter-metro E-Line and E-LAN services in the industry. It also has demonstrated a commitment to support many Ethernet access-based applications and add new features to provide its enterprise and wholesale customers robust, flexible, and affordable services delivered to practically any location using on-network and off-network resources.

**Figure 3.1: Level 3's Ethernet Services Portfolio Overview**



Source: Level 3.

**Figure 3.2: Level 3's Ethernet Services Portfolio Highlights**

|                  | Ethernet Service Name                | Service Type                   | Topology                               | Bandwidth   | Technology                              | Network Protection      | SLA  | Coverage   |
|------------------|--------------------------------------|--------------------------------|--|---|---|-------------------------|--|--|
| <b>Metro</b>     | Ethernet Private Line                | Port-Based Service             | Point-to-Point                         | FastE (Copper)<br>3, 6, 10, 20, 30, 40, 50 & 100Mbps<br>GigE (Fiber)<br>100, 200, 300, 400, 500, 600 & 1000Mbps                                   | Ethernet over SONET                     | Ring Protected          | Availability: 99.999%  | US: 116 Markets<br>EU: 9 Markets*<br><br>*(50Mbps min) |
|                  | Ethernet Private LAN                 | Port-Based Service             | Multipoint (Any-to-Any)                | FastE (Copper)<br>3, 6, 10, 20, 30, 40, 50 & 100Mbps<br>GigE (Fiber)<br>100, 200, 300, 400, 500, 600 & 1000Mbps                                   | Ethernet over SONET w/ Layer-2 Bridging | Ring Protected          | Availability: 99.999%  | US: Selected Markets                                   |
|                  | Ethernet Wavelengths                 | Port-Based Service             | Point-to-Point                         | GigE (Fiber)<br>1000Mbps<br>LAN/WAN PHY (Fiber)<br>10Gbps   | Ethernet over DWDM                      | Unprotected Single Path | Availability: 99.2%  | US: 116 Markets<br>EU: 9 Markets                       |
|                  | Managed Ethernet Access              | IEEE 801.1q VLAN-Based Service | Point-to-Point                         | FastE (Copper)<br>1Mbps – 10Mbps: 1Mbps increments<br>10Mbps – 100Mbps: 10Mbps increments<br>GigE (Fiber)<br>100Mbps – 600Mbps: 50Mbps increments | Ethernet over SONET                     | Ring Protected          | Core Service SLA extended to include Managed CPE   | US: 48 States  |
| <b>Intercity</b> | Ethernet Private Line                | Port-Based Service             | Point-to-Point                         | FastE (Copper)<br>50 & 100Mbps<br>GigE (Fiber)<br>100, 200, 300, 400, 500, 600 & 1000Mbps   | Ethernet over SONET                     | Ring Protected          | Availability: 99.999%  | US: 145 Markets<br>EU: 23 Markets                      |
|                  | Ethernet Wavelengths                 | Port-Based Service             | Point-to-Point                         | LAN/WAN PHY (Fiber)<br>10Gbps   | Ethernet over DWDM                      | Unprotected Single Path | Availability: 99.2%  | US: 183 Markets<br>EU: 38 Markets                      |
|                  | Ethernet Virtual Private Line        | IEEE 801.1q VLAN-Based Service | Point-to-Point;<br>Point-to-Multipoint | FastE (Copper)<br>1Mbps – 10Mbps: 1Mbps increments<br>10Mbps – 100Mbps: 10Mbps increments<br>GigE (Fiber)<br>100Mbps – 600Mbps: 50Mbps increments | Ethernet over MPLS                      | MPLS Fast Re-route      | Application Specific CoS<br>Availability: 99.99%<br>Latency: 5 - 45ms<br>Delivery: 99.95%<br>Jitter: 15ms (Highest CoS)              | US: 48 States<br>EU: 23 Markets                        |
|                  | Ethernet Virtual Private LAN Service | IEEE 801.1q VLAN-Based Service | Multipoint (Any-to-Any)                | FastE (Copper)<br>6, 10, 20, 30, 40, 50, 60, 70, 80, 90 & 100Mbps<br>GigE (Fiber)<br>100, 200, 300, 400, 500, 600, 700, 800, 900 & 1000Mbps       | Ethernet over MPLS/VPLS                 | MPLS Fast Re-route      | Application Specific CoS<br>Availability: 99.99%<br>Latency: 50ms<br>Delivery: 99.99% (w/ Highest CoS)<br>Jitter: 10ms (Highest CoS) | US: 48 States<br>Asia: Selected Countries              |

Source: Level 3.

Beyond leveraging Ethernet throughout its network, Level 3 has many service-related strengths that position it well in today's increasingly competitive Ethernet services market.

**Broad Portfolio Of Ethernet Services And Applications.** Level 3 provides a complete range of EPL, EVPL, and EVPLAN connectivity services, including (1) dedicated SONET/SDH-based point-to-point services; (2) dedicated DWDM-based point-to-point services; (3) a SONET-based multipoint-to-multipoint service; and (4) an Ethernet VPN suite of virtual point-to-point, point-to-multipoint, and multipoint-to-multipoint services based on MPLS/VPLS. The company also offers a Managed Ethernet Access service and supports many of the key Ethernet access-based, including access to MPLS/IP VPNs, VOIP, storage extension, and content delivery (**Figure 3.1**).

**Comprehensive set of Service Level Agreements (SLAs).** Level 3 offers SLAs for all services in its Ethernet portfolio, including availability guarantees across the portfolio and multiple classes of service for its intercity MPLS- and VPLS-based services.

**Extensive Geographical Service Reach.** Level 3 is among a relatively small number of operators that offers all three major classes of standards-compliant Ethernet connectivity services (EPL, EVPL, and EVPLAN) across every geographic distance (metro, regional, national, and international). Level 3 provides on-network, native Ethernet access in 116 U.S. metro markets and 9 European metro markets. In addition, the company offers intercity Ethernet point-to-point connectivity between 145 U.S. markets and 35 European markets (as well as intercity multipoint-to-multipoint connectivity between U.S. markets and parts of Asia).

Level 3 been able to reach so many markets due to the combination of its large fiber network footprint, network centers in more than 100 cities, and Ethernet-connection agreements with numerous local access providers in the U.S. and international markets.

**Dense Service Coverage Within Metro Markets.** Level 3 provides four major Ethernet access options within metro markets: (1) on-network, native Ethernet on-ramps; (2) 3<sup>rd</sup> party provided native Ethernet loops; (3) managed Ethernet handoffs at the customer premises; and (4) cross-connects from Level 3 access points. The combination of these access options gives it considerable flexibility in speeding service turn-up for customers and addressing a broad range of service speed requirements.

**Level 3 provides four Ethernet access options: (1) on-network, native Ethernet on-ramps; (2) 3<sup>rd</sup> party provided native Ethernet loops; (3) managed Ethernet handoffs at the customer premise; and (4) cross-connects in colo space.**

While Level 3 uses Ethernet 3<sup>rd</sup> party native Ethernet loops, the carrier told *Heavy Reading* that the current service delivery process can be challenging due to access vendor provisioning processes, lack of quality standards used by 3<sup>rd</sup> party providers, unpredictable pricing, and the frequent high expense of setting up an Ethernet connection only over fiber.

Level 3 has sought to overcome such obstacles by building out its own fiber connectivity to buildings and investing in its managed Ethernet access solution that reduces its reliance on 3<sup>rd</sup> party fiber providers. Level 3 currently offers Ethernet service to 6,800+ on-network locations, and is adding between 75 to 100 new buildings to its fiber network each month. The managed Ethernet access platform that Level 3 has adopted allows the company to affordably extend its reach to a larger number of off-network customer sites by enabling the delivery of Ethernet over NxDS1s, NxDS3s, OC-3s, and OC-12s, which are reliably provisioned like clockwork. These managed Ethernet handoffs give Level 3 the ability to reach essentially any customer premises with a broadband connection that is as easy to deploy as a private line circuit but is more price-competitive.

**Service Scalability.** Level 3's Ethernet services support data rates ranging from 1 Mbps to 10 Gbps, with various levels of granularity depending on the particular underlying network technology. At the low end, Level 3 envisions 10 Mbps becoming the "T1" of tomorrow because the net-

work edge is no longer constrained by the limits of TDM technology. Enterprise customers, for example, can leverage a single physical connection to access a variety of logical services even at this modest rate. As customers transition to higher speeds, the bandwidth flexibility associated with Ethernet permits them to upgrade in less time than with traditional service step functions. At the high end, Level 3 was among the first major operators to offer 10G LAN PHY in addition to 10G WAN PHY connectivity. Level 3 also is an early advocate for 100 Gbps optical system technologies, which shows its commitment to providing plenty of future scalability for its most demanding enterprise and wholesale customers.

**Universal Service Port & Class of Service.** Level 3's VLAN-based Ethernet services support service multiplexing—a key service feature that enables enterprises to access multiple services such as VoIP, Internet Services and MPLS/IP VPNs over a single user network interface (UNI) and last-mile access connection. To efficiently utilize the service multiplexing feature, Level 3 also supports application-specific Class of Service (COS) at the edge and across the core backbone. Customers can carve out specific amounts of bandwidth per application and prioritize different traffic types using 802.1p based prioritization or elect individual VLANs to be mapped to appropriate traffic classes.

**Web-Based Services Portal.** Level 3 supports a powerful customer management tool, Level(3)Enabled<sup>SM</sup> Portal. This Portal is integrated with Level 3's backoffice and network systems, giving Ethernet customers on-demand access to service information. Enterprises can access ordering, provisioning, and billing information; set and receive automated notification of service benchmarks; monitor port utilization and usage data at the VLAN level; and obtain network performance metrics such as latency, jitter, packet loss, and availability. Ethernet customers can also access service documentation and create, update, and monitor service issues through the Portal's trouble ticketing functionality. Level 3 also plans to offer on-line Ethernet quote generation, providing a complete life-cycle management approach for this service. The Level(3)Enabled<sup>SM</sup> Portal is offered at no additional cost to its Ethernet customers.

## IV. Addressing Requirements Of Key Industry Verticals

Level 3 Communications offers a wide range of capabilities and value-added options that makes its Ethernet services generally attractive to many enterprises, including large businesses with nationwide multipoint connectivity requirements in Tier 1 and Tier 2 markets, as well as small and medium-size enterprises operating primarily within metro areas.

The following discussion highlights some of the major service requirements and Level 3's solutions related to key industry verticals in which Ethernet services have gained significant popularity: financial, healthcare, research & education, and media.

### 4.1 Financial Services

**Service requirements.** Financial firms are among the most demanding when it comes to secure and reliable communications services because problems like downtime and security breaches can negatively impact the sales and reputations of investment banks, securities firms, exchanges, and other financial institutions. Companies in this vertical typically look for service flexibility, fast service provisioning, always-on connectivity, and other carrier-class performance features – including low latency and low packet loss – required for rapid trading and mission-critical applications like ERP, CRM, and SAN. Financial institutions place a priority on being able to respond quickly to shifting market opportunities and threats, and they are constantly looking for ways to consolidate communications functions and make more efficient use of IT resources.

Federal rules – such as SEC/Treasury/Federal Reserve guidelines and the Sarbanes-Oxley Act (SOA) – have placed additional demands on financial institutions to protect the integrity and privacy of financial data, establish recovery goals, and maintain sufficient geographically dispersed

resources to meet those goals. These guidelines particularly increase the data replication and storage requirements for information-intensive financial institutions.

**Level 3 Communications solution.** Level 3 offers a set of high-performance service options to address the tough and diverse requirements of financial firms. One of its most popular offerings for this sector is the Ethernet Private Line (EPL) service. This service is frequently used for data center connectivity and business continuity/disaster recovery (BCDR) applications. Customers also have been attracted by Level 3's ability to deliver low latency Ethernet connectivity that helps speed execution of trades and access to market data.

Level 3's Ethernet VPN service has found appeal among financial firms due to its high service availability, capability to consolidate mission-critical and non-mission critical applications on a single infrastructure, and support for storage-over-Ethernet and disaster recovery applications within regions and across the nation. Level 3's Ethernet VPN is well-suited to address requirements of banks and other firms because of the service's ability to support n x DS1 connectivity to locations that may not be on a fiber network.

## 4.2 Healthcare

**Service requirements.** The healthcare industry's primary service needs include massive amounts of secure, affordable bandwidth for non-emergency administrative and real-time clinical applications and simplification and consolidation of communications functions for the purpose of boosting overall productivity, reducing errors, and driving out fraud and waste. While the industry historically has committed a lower than average share of budget to IT, multiple forces are converging to drive a rapid increase in telecom spending and migration from legacy FR and private line services to newer, more efficient Ethernet and IP VPN services.

Explosive growth in the transmission of high-resolution digital images and interactive television (IATV) is placing greater bandwidth and service performance requirements on communications networks. Bandwidth hungry teleradiology – the sending of x-rays, MRIs, and CT scans and consultative text – is the most common type of telemedicine application today, and its use continues to grow rapidly. IATV, meanwhile, is used for medical training and real-time consultation between physicians or radiologists. Participants need a reliable, high-bandwidth connection that permits them to synchronously manipulate high-resolution images and perform interactive interpretation.

In addition, the national health system is burdened by a heavy reliance on paper-based, labor intensive and error-prone information management processes that cost thousands of lives per year. Moreover, industry experts estimate tens of billions of dollars are lost annually due to medical errors, false insurance claims, and widespread Medicare and Medicaid fraud that can be traced to out-dated record keeping and poor checks-and-balances.

Congress passed the Health Insurance Portability and Accountability Act (HIPAA) in 1996 to help control healthcare business costs and reduce medical errors, waste, and fraud by encouraging electronic transactions. The provisions of the law aimed to protect the security and confidentiality of patient information started to go into effect in 2003, and telecom operators have been working since then to help health care companies address HIPAA requirements. The combined mandates to retain private records at least six years and evolve to electronic recordkeeping have led many hospitals and other healthcare companies to seek high-bandwidth connectivity linking multiple sites to help keep information management costs in check.

**Level 3 Communications solution.** Level 3 can address key healthcare communication needs by delivering a comprehensive set of solutions drawing upon its Ethernet services portfolio and other next-generation services capabilities.

Level 3 Ethernet VPN enables Level 3 to provide Ethernet connections to support rapid transmission of high-resolution images to and from sites with or without fiber connectivity. And Ethernet VPN's high availability ensures facilities like radiology centers that process large digital image files can deliver reliable, round-the-clock services to hospitals and other healthcare facilities. Lev-

Level 3's Ethernet VPN is well-suited to address technology/service migration requirements of hospital systems and Integrated Delivery Networks (IDNs) with a large number of facilities scattered around the country.

Level 3's ability to support many services like VOIP, Internet access, video transmission, and storage transport over a single interface at multiple locations can help healthcare companies simplify their communications infrastructure, consolidate administrative functions, centralize picture archiving communication systems (PACS) assets, and streamline other business processes.

Level 3's Ethernet VPN service can help ensure healthcare providers cost-effectively meet federal requirements for privacy and integrity of electronic health information whether information is transmitted and stored within a city or is kept at multiple sites around the country.

### 4.3 Professional Services

**Service requirements.** Law, accounting, consulting, and other professional services firms are particularly in need of secure communications, real-time document management, and reliable video conferencing

**Level 3's pure Layer 2 VPN solution is not subject to many of the security threats posed by IP VPN services.**

across the WAN to support consultation and collaboration within firms and between firms and clients. They also require remote document repositories, strong disaster recovery and business continuity solutions, and support for huge file downloads. Rock-solid security to protect client-confidential information is a must. Like other industry verticals, professional services firms are transitioning away from manual processes and paper increasingly in favor of electronic documents to increase business efficiency, control file storage and retrieval costs, and strengthen record-keeping mechanisms. Law firms, in particular, must also address state, federal and local mandates that require technology for compliance issues or regulate technology use. Controlling costs, increasing profitability, and improving service and communication with clients can present a real challenge for many professional services firms.

**Level 3 Communications solution.** Level 3 offers a variety of Ethernet service capabilities that have a broad appeal within the legal vertical, primarily because Level 3 can offer secure E-Line services and a pure Layer 2 VPN solution that is not subject to many of the security threats posed by IP VPN services. Level 3's Ethernet-over-TDM local access can ensure remote sites are connected with key professional services data centers, and the operator's ability to offer bandwidth granularity helps remote locations get bandwidth tailored for their needs, offering opportunities to control costs and grow bandwidth as needed. The challenge of managing integration of different WANs due to acquisition or consolidation is easily answered with Ethernet VPN. Its high service availability, broad geographic reach, and support for Ethernet access-based storage transport and disaster recovery fits well with the document management needs of legal, accounting, and other professional firms.

### 4.4 Media

**Service requirements.** Media and entertainment companies have traditionally required reliable, efficient, and scalable services that can support large volumes of video traffic. More recently, enterprises in the media vertical have added Internet, CDN, WAN data, and WAN voice to their list of requirements— especially when this array of services can be provided over a single interface and supported over long distances. As a rule, there is little, if any, tolerance for service downtime, particularly when it comes to covering live events in which millions of advertising dollars could be on the line for media outlets and entertainment providers. Because of this, large media and entertainment companies often are hesitant to trust their important live broadcasts to new or unproven technologies.

**Level 3 Communications solution.** For more than 15 years, Level 3's Vyvx unit has been involved in broadcast video transmission and advertising media distribution, providing more than

250,000 fiber and satellite video feeds per year—including for the most widely watched events like the Super Bowl, the World Series, and the NCAA Final Four. Level 3's broad and deep Ethernet Service portfolio—coupled with proven media networking solutions—creates service diversity for media and entertainment companies previously not available from traditional technologies. Level 3's Ethernet service portfolio offers high service availability, traffic prioritization, and up to 10 Gbps bandwidth rates, allowing it to support demanding applications like video transport and content distribution. Level 3's Ethernet services enable data and long-distance voice to be carried over the same local access on-ramp. Level 3's Managed Ethernet Access service extends this capability to a large number of locations by creating service availability any place SONET/TDM local loops are available. The operator's wide-reaching connectivity to every major professional sports venue and media center, as well as long-standing relationships with major broadcasters and media/entertainment companies, should further position the operator to successfully address customer requirements in this market.

**Managed Ethernet Access extends enhanced service capabilities to a large number of locations by creating service availability any place SONET/TDM local loops are available.**

## V. Conclusion

Business-class E-Line and E-LAN services from leading operators like Level 3 give enterprises access to high-bandwidth, high performance solutions tailored to their needs without sacrificing the reliability and service quality characteristic of traditional data services.

New carrier Ethernet services are ideally suited for many requirements of finance, healthcare, research & education, and media verticals. Today's next-generation Ethernet solutions are especially attractive because they provide secure, reliable, efficient, and scaleable communications services that support large volumes of data, voice and video traffic while controlling costs and maximizing in-house IT productivity.

Our research indicates Level 3 Communications has one of the most flexible and feature-rich Ethernet portfolios in the market. This service provider delivers cost-effective solutions to smoothly migrate data services customers toward Ethernet, eliminates many of the pain points that have previously prohibited enterprises from embracing this technology, and offers a compelling Layer 2 alternative to Layer 3 IP VPNs.